5

SERVICE PROCEDURES

5. SERVICE PROCEDURES

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FIGURES

TABLES

Table 5.1 Laser servicing schedule

WARNING

THESE PROCEDURES SHOULD BE CARRIED OUT ONLY BY TRAINED PERSONNEL

MAXIMUM SERVICE INTERVAL	PROCEDURE	MANUAL REFERENCE
Before each operation of laser	Check lamps and indicators	Chapter 6
Every 300 operating hours	Check vacuum pump oil level	Chapter 6
	Remove metal deposits and recharge	5.1.6
	Clean windows	5.1.2
	Inspect electrodes	5.1.5
	Check vacuum integrity, recondition	5.1.3
	Check gas flow and pressure	
	Check Thyratron voltages	5.2.1
	Align optics	5.1.4
Every 600 operating hours	Replace Thyratron oil	5.2.2
Every six months	Service vacuum pump	5.3.1
	Check operation of interlocks	

5. SERVICE PROCEDURES

The service procedures for Oxford Lasers Compact Metal Vapour Lasers are described in three main sections: the Laser Head, the High Voltage (right side) of the PSU, and the Control circuits (left side) of the PSU. These procedures should be carried out only by trained personnel.

5.1 SERVICE PROCEDURES FOR THE LASER HEAD

5.1.1 Minimisation of Contamination of the Laser Head

Some procedures relating to the servicing of the laser head require the vacuum integrity of the laser head to be breached. Contamination of the laser head due to the admission of air, and especially moisture, can lead to serious faults in the entire system. Great care needs to be taken, therefore, to reduce contamination of the system during servicing.

The recommended procedure in all cases where the vacuum integrity of the system is to be breached by removing one of the windows is as follows:

1) Remove only one window at any one time.

2) Wait until the laser tube is cold before removing a window.

3) Keep a continuous flow of gas through the laser while a window is removed by closing the **GAS OUT** manual regulating valve - see section 5.3.2 "Using the Manual Gas Controls".

4) If a window is removed and further access is not required (for example, while the window is cleaned), a clean wad of cloth or tissue should be placed in the opening to minimise the flow of air into the system.

5.1.2 Cleaning the Laser Windows and Mirrors

The laser windows and mirrors will not usually need to be cleaned with any greater frequency than that required for recharging the laser with copper. Consequently, contamination can be reduced by ensuring that the two operations of cleaning the windows and replenishing the metal charge are carried out at the same time. Inspection of the electrodes (see section 5.1.5) and checking of the level of the copper charge (see section 5.1.6) should be carried out as a matter of course whenever a window is removed. The procedure is as follows:

1) Fill the laser tube with neon to a pressure greater than atmospheric, as indicated on the laser gas pressure gauge. If the laser pressure is below atmospheric, close the **GAS OUT** manual regulating valve and select **FAST GAS IN**. The time for the laser to fill from operating pressure to atmospheric pressure will normally be less than 20 minutes.

2) Remove the beam path cover at one end of the laser head. Loosen the screws which hold the window retaining ring onto the end flange. Loosen each screw a small amount at a time, so that excessive strain is not put on the silica window at any one point.

3) Take care to hold the window retaining ring in place with one hand while the screws are removed with the other. Carefully tilt the retaining ring out at the top, so that the window is held in the depression. Escaping gas may be heard as the seal is broken. Avoid fingerprint contamination of the inner and outer surfaces of the window.

4) Place a wad of tissue or clean cloth in the opening of the end flange to minimise air contamination.

5) Remove the window from its retaining ring. Always handle the windows by the edge only. Inspect the surface of the window which was facing the inside of the laser tube. Any deposits should be CAREFULLY removed with a finger nail. The laser windows on a Compact laser are Anti-Reflection coated on one side. This coated side should always be on the outside surface when the window is fitted to the laser.

6) When any deposits have been removed, the surface of the window can be cleaned using an isopropyl alcohol based cleaner, or the cleaning fluid provided in the complimentary spares kit. Ensure that lint-free tissue is used to clean the window, and that no traces of cleaning fluid are left.

7) Because it is undesirable to open the laser tube at frequent intervals, it is suggested that the level of copper or gold charge is checked, and the electrodes are inspected while the window is removed. Refer to sections 5.1.5 and 5.1.6 for these procedures.

8) Remove the O-ring from its groove and wipe it with a lint-free cloth. Similarly wipe the O-ring groove to remove any dust deposits. Replace the O-ring which may first be smeared with a little vacuum grease if available.

9) Replace the window in the recess in the retaining ring ensuring that the Anti-Reflection coated side will be on the outside when the window is fitted. The coated side should be marked with an arrow on the rim of the window. If it is not, it is usually possible to see the edge of the coating on one side of the window as a coloured ring close to the rim. Scrupulously avoid fingerprint contamination of the inner and outer surfaces of the window. Replace the retaining ring against the end flange, taking care not to let the window drop out. Replace the four screws and tighten them EVENLY until resistance is just felt.

10) This procedure can now be repeated for the window at the other end of the laser head.

Note: Fit the external pressure gauge now if required (see 5.1.3 below)

11) Close the GAS IN manual regulating valve and select FAST PUMP OUT. When the pressure is 100mbar or less, retighten the retaining ring screws EVENLY until resistance is just felt.

12) If necessary, clean the silica output coupler at the output end of the laser head using lint-free tissue. Do not use abrasive cleaner on the mirror coating at the other end of the laser.

13) Finally, return the gas controls to their normal positions: the FAST GAS IN and FAST GAS OUT override switches should be up and both the GAS IN and GAS OUT manual regulators should be fully open (i.e. fully anticlockwise).

5.1.3 Reconditioning the Laser following Minor Servicing

Some reconditioning of the laser tube will be required after servicing the laser head, even when precautions against contamination have been taken. The initial steps to be taken once both laser windows have been replaced are:

a) Fit a pressure gauge in line with the existing gas out manifold gauge on the laser head; a blanked port is provided for this purpose.
b) Ensure the "T" tap on the rear panel of the PSU selects either Internal or External gas supply as appropriate.
c) Close the GAS IN manual regulating valve.

The system can now be evacuated by selecting FAST GAS OUT. This will allow the system to pump out without starting the standard operation cycle. Leave the system to pump out for 30 to 60 minutes. After this period the FAST GAS OUT switch should be returned to its closed (up) position. The laser should then be left for two hours and the gas pressure checked for any increases. A rise of more than 1 mbar on the laser pressure gauge constitutes an unacceptable leak which must be traced and repaired before proceeding.

Note: Large pressure rises may be due to out-gassing from the laser head when the system has been left open to the atmosphere for long periods.

If there is no leak, return all gas controls to their normal positions and start the laser using the operation procedure described in chapter 4, section 4.3.4. If the dirt monitor interlock should cause the laser to trip out (see Chapter 6 - Fault Finding), then wait until the interlock resets itself and try again.

5.1.3.1 Condition Timer

The Compact Laser Condition Timer automatically controls the Fast Gas In and Fast Gas Out valves to provide increased gas flow whilst the laser is warming up. For a cold laser tube, the Condition Timer will control the gas flow rates for about 32 minutes from starting the laser (and thus about 25 minutes after the start of the discharge). During the initial period of thyratron warm-up, only the Fast Gas Out valve will be activated.

A hot laser must be left for about an hour before the Condition Timer will again give a full period of fast gas flow; the period is reduced with shorter cooling times, and is zero if less than 25 minutes have been allowed from the turn off time. The Condition Timer overrides the autosequenced pump-out during thyratron warm-up if the laser tube is still hot.

5.1.4 Alignment of Laser Mirrors

Alignment of the laser mirrors is best performed when the laser has reached its normal operating temperature. Alignment is not a difficult procedure because copper lasers are very high-gain systems. Consequently, lasing will occur even with the mirrors slightly misaligned. Alignment of the laser cavity is merely an optimisation procedure which will increase the power from a low, but not insignificant, level.

For CU10-A/DL10K and CU15-A/DL10K systems, the front mirror is fixed. The cavity should be aligned by adjusting the set-screws on the rear mirror mount using a matt black Allen key.

For all other automatic control metal vapour laser systems, the following alignment procedure should be used:

1) Remove the front mirror from its mount.

2) Run the laser up to its normal operating temperature.

3) Direct the laser beam into a fast-response power meter.

4) Using a matt black Allen key, adjust the set-screws on the mirror at the HV end of the laser head until maximum output power is attained. When observed, the laser beam should be central in the surrounding glow.

5) Switch off the laser by pressing the STOP switch.

6) Replace the front mirror.

7) Restart the laser (allowing for the 7 minute warm-up).

8) When the laser output has stabilised, adjust the set-screws on the front mirror mount, using a matt black Allen key, until maximum output power is attained. DO NOT USE A CHROME-PLATED ALLEN KEY.

5.1.5 Inspection/Replacement of the Electrodes

There are two electrodes in the laser head: one in each end flange. The electrodes consist of a perforated metal foil supported in a stainless steel holder. In order to remove the electrodes, first remove the laser window, as described in section 5.1.2. It is then possible to remove the foil using a pair of long nose pliers.

The electrodes should not normally need replacing with new parts. However, operating the laser for extended periods when the laser tube is contaminated can cause erosion of the electrodes. The laser will still operate normally with partially eroded electrodes, but, if the electrodes are thought to be significantly damaged, Oxford Lasers or its distributor should be contacted.

WARNING

THE ELECTRODES HAVE SHARP EDGES AND THEREFORE CARE SHOULD BE TAKEN WHEN HANDLING THEM

5.1.6 Recharging the Plasma Tube with Copper

The need for recharging the metal load can be determined when laser output is seen to drop dramatically over a short period (about eight hours).

Copper wire of the quality used in good electrical installations is of sufficient purity for recharging copper vapour lasers.

The CU10-A requires eleven individual portions of the metal, each weighing approximately 1 gram. The CU15-A requires 17 such portions. A spare copper charge is provided with the complimentary spares kit; this consists of copper wire of approximately 2mm diameter and 2cm in length, folded in half.

If any copper has collected at the ends of the plasma tube and is aperturing the beam, it should be removed. Use the loading tool to carefully remove these deposits. It should be noted that this process may result in severe contamination of the system. The system will have to be reconditioned using the procedure outlined above in section 5.1.3.

The recharging procedure is as follows:

1) Fill the laser to atmospheric pressure, as described in section 5.1.2, step 1.

2) Remove the front mirror and one laser window, as described in section 5.1.2, steps 2 and 3.

3) Place the metal charges at the markers on the loading tool provided.

4) Insert the loading tool into the laser tube to the point indicated on the tool, i.e. so that the mark on the loading tool is in line with the outside surface of the end flange.

5) Rotate the loading tool through 180 degrees to deposit the metal charges, then carefully withdraw the tool, holding it lightly against the top of the plasma tube so that none of the metal charge is dislodged.

6) Replace the laser window and the front mirror.

7) Return the gas controls to their normal positions.

8) Recondition as described in section 5.1.3.

9) Once stable laser output is reached, realign the output coupler for optimum power.

5.2 SERVICE PROCEDURES FOR THE HIGH VOLTAGE (RIGHT) SIDE OF THE PSU

5.2.1 Checking Grid Bias and Heater Voltages of the Thyratron

CAUTION:

POWER SUPPLY VOLTAGES ARE PRESENT WHEN INTERLOCKS ARE NOT OVERRIDDEN. HIGH VOLTAGES MAY BE PRESENT WHEN INTERLOCKS ARE OVERRIDDEN

1) Remove both PSU side panels and the HT side safety screen. Test points for the grid bias and heater voltages are situated on top of the thyratron tank which is located in the high voltage side of the PSU.

   Turn on the power via the key switch (remember, PSU interlocks have been broken by removal of the side panels). To start the laser, PSU interlocks will have to be overridden. This is done by switching over the PSU interlock override toggle switch which is located on the motherboard in the control circuits side of the PSU.

   Once the PSU interlocks have been overridden, the ready lamp on the front panel will begin to flash, indicating that it is possible to start the operation procedure. Depressing the start button will supply power to the grids and the thyratron heater. Even though the panel interlock is overridden, the HT will not turn on after 7 minutes. HT is only possible with the panels in place and the panel interlock not overridden. As a further safety precaution pull out the 20A High Voltage Power Cut-out circuit breaker at the back of the PSU.

2) Place the mode selector switch on the frequency control unit in the EXT position to suppress the trigger pulse on the negative grid. The positive grid voltage must be measured when the thyratron heaters are cold. Use a multimeter to check the positive grid voltage which should be between +160V and +190V.

3) Check the negative grid voltage with a multimeter; this should be between -160V and -190V. If the grid values are found to differ from their specified values by more than 10%, the cause of the variation should be investigated.

4) Check the heater voltage which should be 6.5VAC. If the heater voltage is outside 5% of its correct value it must be adjusted according to procedures 5 and 6.

5) First check that the power supply voltage is not low or high. The voltage should be within the range 208 to 250VAC.

6) The heater voltage should then be set to 6.5V by selecting the tapping on the multi-tapping transformer which gives a voltage closest to the required value.

7) The positive grid voltage falls when the thyratron heaters are operating with a limited current flow. A few minutes after switch-on the positive grid voltage will be seen to fall rapidly from between 160V and 190V to a value nearer 50V. Over the next few minutes the voltage will be seen to fall further, with a possible temporary rise, to settle at a value somewhere between 18V and 35V.

   This steady state voltage can be used as a monitor of the condition of the thyratron. When the thyratron is new, a voltage of between 18V and 24V will be measured. As the thyratron ages this voltage will rise. If the settled voltage of the positive grid reaches 32V, the thyratron is due for replacement. It should be noted that if the thyratron is left unused for any great length of time, this measured voltage will become high. Operation of the thyratron for a number of hours will cause the voltage to fall again.

5.2.2 Replacement of Oil in the Thyratron Tank

The transformer oil with which the thyratron tank is filled degrades with time due to corona discharge from the high voltage components. This degradation is a slow process and the oil should need to be checked only once every 600 hours of operation. Badly degraded oil, however, can be responsible for surface tracking on the HV components, resulting in unreliable operation. Note that operation at high ambient temperatures (25 to 30°C) will increase the rate of oil degradation.

Oxford Lasers recommends that the oil be changed every 600 hours.

When refilling the tank with oil, it is important not to overfill it. The required volume of oil is 4.7 litres.

5.3 SERVICE PROCEDURES FOR THE CONTROL CIRCUITS (LEFT) SIDE OF THE PSU

To obtain access to the left hand side of the PSU, keep one hand on the panel to prevent it from falling, and use a screwdriver to turn each screw to a position where its slot is parallel to the nearest edge of the panel. It will then be possible to take out the panel.

Service procedures in the PSU are, again, limited. The required frequency of servicing of the vacuum pump is given in the manufacturer's documentation, which is included in Chapter 11 of this manual. The function of the manual gas controls is briefly described in section 5.3.2.

5.3.1 Servicing the Vacuum Pump

It should be clear, both from this chapter and from elsewhere in this manual, that the cleanliness of the laser vacuum system is crucial for correct laser operation. The rotary pump installed in the laser is an integral part of the vacuum system. All rotary vacuum pumps require regular servicing in order to ensure proper operation. A pump which is poorly or irregularly serviced can cause problems in the laser.

The manufacturer's service and operation instructions for the vacuum pump are included in Chapter 11 of this manual. Refer to this documentation for all vacuum pump servicing information. The usual minimum requirement for vacuum pump servicing is the regular changing of the pump oil and the oil filter. The pump seals should be checked and, if necessary, replaced during these servicing operations.

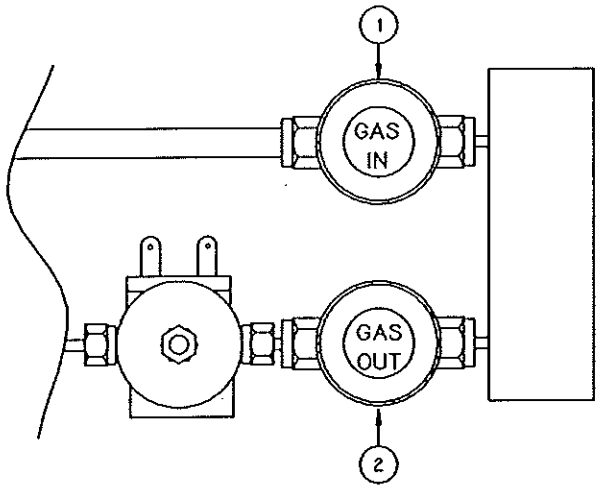
5.3.2 Using the Manual Gas Controls

The manual gas controls are shown in Figure 5.1 and Figure 5.2, and comprise the following: The GAS IN Manual Regulating and Shut Off Valve, the GAS OUT Manual Regulating and Shut Off Valve, the FAST GAS IN Override Switch, and the FAST GAS OUT Override Switch.

The GAS IN Manual Regulating and Shut Off Valve shuts off all gas feed to the laser. The GAS OUT Manual Regulating and Shut Off Valve shuts off the vacuum pump. Under normal running, both valves will be fully open (fully anticlockwise). Both these valves can be used in the regulating mode by experienced service personnel in order to accelerate laser tube conditioning following severe contamination or tube replacement.

The FAST GAS IN Switch activates the Gas In solenoid valve, allowing gas to bypass the Gas In flow restrictor. This switch is used to fill the laser head with gas. The FAST GAS OUT Switch activates the Gas Out solenoid valve, allowing gas to bypass the Gas Out flow restrictor. This allows the laser head to be evacuated more quickly during conditioning. The switches are active in the down position and inactive in the up position.

When cleaning the laser windows or recharging the plasma tube with copper or gold (see sections 5.1.2 and 5.1.6 respectively), the laser head should be filled with gas by fully closing the GAS OUT Manual valve, and then activating the FAST GAS IN Override Switch.



No.	Manual Gas Control
1	GAS IN Manual Regulating and Shut Off Valve
2	GAS OUT Manual Regulating and Shut Off Valve

Figure 5.1 Manual gas control valves

No.	FAST GAS Controls
1	FAST GAS IN Override Switch
2	FAST GAS OUT Override Switch

Figure 5.2 Manual gas override switches